A survey of the selenium status of beef cows in Alberta

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Abstract

An epidemiological survey was conducted in Alberta to measure the selenium status in blood of beef cows during the fall and to determine the risk of selenium deficiency among specific geographic regions of Alberta.

Three census divisions of Alberta based on the Statistics Canada Census of Agriculture were chosen as the study areas for the project. Soils and plants in area A (Edmonton area) and area B (Calgary area) were known to be deficient in selenium, while soils and plants in area C (southeast corner of Alberta) were known to have adequate levels of selenium. Blood samples were collected from 335 cows on 29 farms from the 3 study areas. These samples were collected from cows that had recently been removed from pasture in October and November 1992. Answers to a short questionnaire pertaining to various herd characteristics and management practices were also obtained for each herd.

The average value of selenium for all cows sampled was 2.20 µmol/L. The average value of selenium of cows in areas A and B was 1.93 µmol/L. The average value of selenium of cows in area C was significantly ($P < 0.05$) higher at 2.70 µmol/L. Nine percent of the cows in the study were considered marginal or deficient in selenium (<1.27 µmol/L selenium).

Herds located in area C, herds that were provided with supplemental feed on pasture, and herds that were pregnancy checked had higher average herd selenium values than did other herds. Cow-calf producers located in areas with selenium-deficient soils should pay particular attention to selenium supplementation for their cows. Some of the negative "geographic" effects on selenium values can be overcome by more progressive management practices.

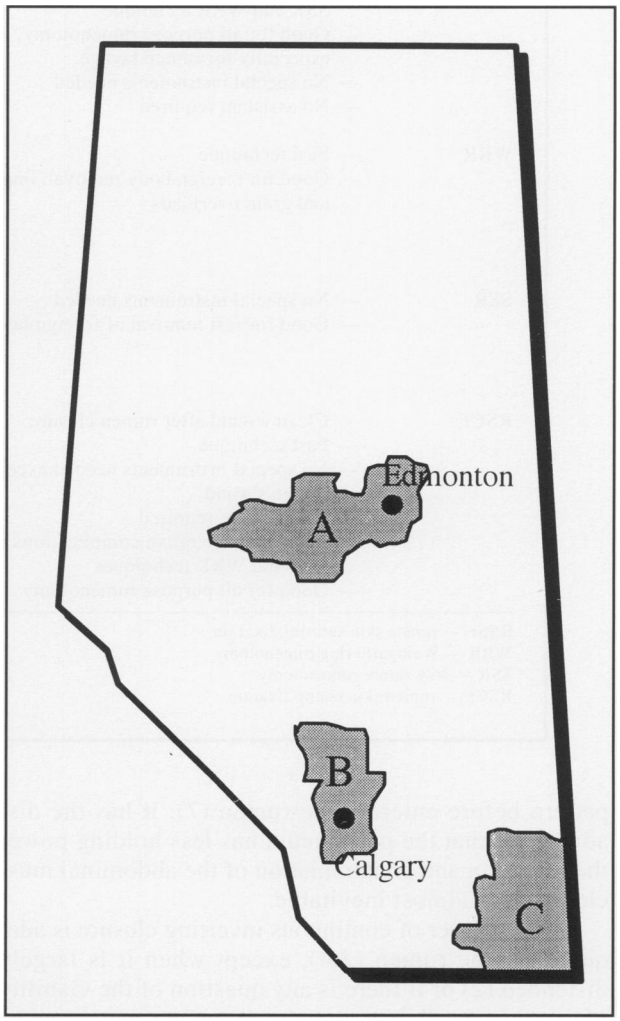

Figure 1. Alberta census divisions used for sample selection (10).

Résumé

Dosage du sélénium chez les bovins de boucherie en Alberta

Une étude épidémiologique a été effectuée pour déterminer les taux de sélénium sanguin chez les bovins de boucherie et pour déterminer le facteur de risque d'une carence en sélénium durant la période automnale selon les régions démographiques en Alberta.

Trois régions ont été choisies pour l'étude selon les données statistiques de recensement d'Agriculture Canada. Les taux de sélénium étaient considérés comme déficients dans les plantes et le sol des régions A (Edmonton) et B (Calgary) et adéquats pour la région C (sud-est albertain). Les échantillons sanguins ont été prélevés sur 335 vaches réparties sur 29 fermes des trois régions. Les animaux avaient été retirés du pâturage aux mois d'octobre et de novembre 1992. Un bref questionnaire a été complété pour chaque ferme sur les méthodes de régie et sur les caractéristiques du troupeau.

La valeur moyenne de sélénium pour toutes les vaches était de 2,20 µmol/L. Pour les régions A et B, la valeur moyenne était de 1,93 µmol/L alors que celle de la région C était plus élevée de façon significative ($P < 0,05$) à 2,70 µmol/L. Neuf pourcent des vaches présentaient des taux faibles ou marginaux en sélénium (<1,27 µmol/L). Les troupeaux de la région C, ceux recevant un supplément au pâturage

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Table 1. Summary of descriptive statistics collected from questionnaire from all herd owners who responded to survey and in herds whose owners provided blood samples

	Area A		Area B		Area C		Total	
Variable	Survey	Sampled	Survey	Sampled	Survey	Sampled	Survey	Sampled
Number of herds	18	7	18	13	12	9	48	29
Average herd size (cows)	61.8	73.6	69.2	70.1	87.8	92.6	71.1	77.9
Average pasture acreage	459	697	343	337	1624	1860	707	896
Average # of pastures	4.8	5.3	5.2	4.8	3.8	3.1	4.7	4.4
% of herds giving mineral with Se on pasture	77.8%	85.7%	61.1%	61.5%	41.7%	44.4%	62.5%	62.1%
% of herds giving injectable Se to cows	22.2%	42.9%	22.2%	23.1%	25.0%	33.3%	22.9%	31.0%
% of herds using supplemental feeds on pasture	33.3%	28.6%	16.7%	23.1%	33.3%	22.2%	27.1%	24.1%
% of herds utilizing pregnancy diagnosis	50.0%	42.9%	66.7%	69.2%	75.0%	66.7%	62.5%	62.1%

Table 2. Average values of Se in whole blood in cows from 3 geographic areas of Alberta

	Area A	Area B	Area C	Total
Mean selenium (μmol/L)	1.93	1.93	2.70	2.20
95% confidence interval	(1.80,2.06)	(1.81,2.05)	(2.54,2.87)	(2.11,2.29)
Number of cows	83	134	118	335
Proportion of deficient and marginal cows (Se < 1.27 μmol/L)	0.121	0.105	0.051	0.090
95% confidence interval (adjusted for clustering)	(0.00,0.316)	(0.041,0.168)	(0.011,0.093)	(0.034,0.15)

et ceux dont les femelles étaient surveillées durant la gestation présentaient des taux moyens en sélénium plus élevés que les autres. Les éleveurs de troupeaux vaches-veaux des régions où le sol est déficient en sélénium auraient avantage à fournir un supplément à leurs vaches. Une régie plus progressive peut contrer certains aspects géographiques négatifs sur les taux de sélénium.

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Introduction

Selenium (Se) is recognized as an essential trace mineral for ruminants (1). Selenium deficiency has been associated with a variety of clinical and subclinical conditions in cattle, including myocardial and skeletal muscle necrosis, increased calf morbidity, reproductive inefficiency, mastitis, reduced weight gain, and pneumonia (2–6). In addition, Se deficiency may suppress the immune system and generally increase susceptibility to infectious disease (7,8).

Selenium moves through a soil-plant-animal cycle. Alkaline and well-aerated soils provide higher amounts of available Se to growing plants than do acidic, poorly-aerated soils (9). This increased availability of Se is mainly due to the chemical form of the Se in the soil and not to its absolute concentration. Lush forage will also tend to have lower concentrations of Se, because of the dilution effect of the abundant plant growth (9).

Soil-type maps and Se analyses in forages have helped to distinguish in which geographic areas cattle are more likely to experience Se deficiencies based on anecdotal evidence and field observations. However, few scientific studies have examined the extent of the "geographic" effect on actual values of Se in cattle, and to what extent these values can be affected by management practices.

The objectives of this project were to survey the Se status of the blood in beef cows in Alberta during the fall,

Table 3. Description of variables evaluated in a linear regression model of average value of selenium in herds

Variable Name	Description
HIAREA	Is herd from high Se area (area C)? (yes = 1, no = 0)
CONTGRAZ	Is the pasture management system using a form of continuous grazing? (yes = 1, no = 0)
MINERAL	Is mineral with selenium given as a supplement while on pasture? (yes = 1, no = 0)
INJECT	Are the cows given Se injections? (yes = 1, no = 0)
PASTFEED	Are the cows given supplemental feed while on pasture? (yes = 1, no = 0)
PREGCHK	Is pregnancy diagnosis utilized? (yes = 1, no = 0)
COWNUM	Number of cows in the herd
ACREAGE	Number of acres of pasture available

and to determine if the risk of deficiency varied among specific geographic regions of Alberta.

Materials and methods

Three census divisions (13,6, and 1) from the 1991 Statistics Canada Census of Agriculture were purposely chosen as the study areas of interest (10). Two of these areas (A,B) were defined as high-risk areas for Se deficiency, due to low Se levels in soils and forages (Fig. 1). One area (C) was defined as a low-risk area for Se deficiency, because adequate levels of Se are present in its soils and forages (Fig. 1). The determination of high-risk and low-risk Se deficiency areas was based on current soil maps and Se values in forages submitted to laboratories of the Alberta Department of Agriculture, Food and Rural Development. Areas A, B, and C corresponded to census divisions 13, 6, and 1.

Through the auspices of Statistics Canada, a letter and a short questionnaire were sent to 75 randomly selected, cow-calf producers in each of the 3 census areas on September 10, 1992. The target population included those cow-calf producers who were listed in the 1991 census as having more than 18 cows. The identity of the 225 randomly selected producers was known only to Statistics Canada, so only those producers who returned the survey could be contacted. In this way, the confidentiality of the Statistics Canada census process was maintained.

Those producers who returned the questionnaire and agreed to participate in the study were sent heparinized blood vials and needles and asked to have their veterinarian take whole blood samples from 10% of the cows on their farm. Each producer was instructed to collect the samples in a systematic, random fashion (every n^{th} cow through the chute). If the herd had less than 100 breeding females, the producer was asked to have blood samples taken from a total of 10 cows. These blood samples were collected during the months of October and November 1992 from cows that had recently been removed from pasture.

The heparinized blood samples were sent to Schering-Plough Animal Health Laboratory, Elkhorn, Nebraska, USA for determination of whole blood Se values. One milliliter aliquots of whole blood were wet digested in a mixture of phosphoric and nitric acid at 185°C for 20 min. After cooling, samples were further digested at 185°C for 20 min in hydrogen peroxide. Samples were cooled once more and then digested at 135°C for 10 min in formic acid, cooled, and digested again at 135°C for a further 10 min in hydrochloric acid. The samples and appropriate standard solutions were analyzed for Se by vapor hydride generation on an atomic absorption spectrophotometer (11).

The questionnaire and the data for the blood value of Se for each farm were organized into a database format using an electronic database program (Paradox for Windows 1.0, Borland International Inc., Scotts Valley, California, USA) and checked for validity. The blood values of Se were categorized as deficient or marginal if the whole blood Se was <1.27 μmol/L (2). Both the actual value and the categorical status of the blood value of Se were included in this data set. The data sets were analyzed using the SAS System for Personal Computers, Release 6.04 (SAS Institute Inc., Cary, North Carolina, USA). The average value of whole blood Se was calculated for each farm in the data set. Simple descriptive statistics were used to summarize the questionnaire data.

The proportion of Se-deficient and Se-marginal cows was calculated for each geographic area; the 95% confidence intervals for these proportions were adjusted for clustering by farm, using a method described by Donald and Donner (12).

Least squares multiple linear regression was used to evaluate the relationship among the average value of Se in the herd and various management and other herd factors. These variables were offered to the model in a stepwise fashion (13).

Results

Forty-eight (21.3%) producers responded to the initial survey. Twenty-nine of the initial 48 responders cooperated by collecting blood samples for the survey. Therefore, the overall response rate was 12.9%. A summary of the results from the initial questionnaire is presented in Table 1. Three hundred and thirty-five blood samples were analyzed for whole blood Se from 29 herds. The mean value of Se in blood for all cows sampled was 2.20 μmol/L. The mean value for all cows sampled from area C was significantly ($P < 0.05$) higher than the mean value for cows from areas A and B. Nine percent of the cows sampled were either deficient or marginal with respect to Se status. The proportion of cows that were deficient and marginal did not vary significantly ($P > 0.05$) among geographic areas, after adjusting for clustering. The results of the Se analyses are summarized in Table 2.

A number of variables were created from the questionnaire data (Table 3). Three of these variables were significant ($P < 0.05$) predictors of the average herd value

Table 4. Summary of linear regression model of average value of selenium in herds

Variable	Regression coefficient	F statistic	Partial R^2	Probability >F
Is herd from a high selenium area?	0.118	84.63	0.3967	<0.01
Was supplemental feed given on pasture?	0.0628	4.65	0.0916	0.04
Was pregnancy diagnosis performed?	0.0281	4.11	0.0722	0.05

R^2 = coefficient of determination

of Se in the linear regression model. Herds located in area C, herds that were provided with supplemental feed on pasture, and herds that were pregnancy checked had significantly higher average herd values of Se than did the other herds ($P < 0.05$). The coefficient of determination (R^2) for the final model was 0.56. This means that 56% of the variation in the average value of Se in herds was explained by this model. The final model is summarized in Table 4.

Discussion

This study demonstrated significant differences in blood values of Se between cows from the high-risk Se deficiency areas (A and B) and cows from the low-risk Se deficiency area (C). This "geographic" effect is likely due to the Se values in soils and plants in these areas. Area C did tend to have a lower proportion of deficient and marginal cows; however, this trend was not statistically significant.

The "geographic" effect was also evident in the linear regression model of the average value of herd Se and suggested that herds from the low-risk area had average Se values that were 1.50 μmol/L higher than those of herds from the high-risk areas. This variable accounted for most of the variation in average herd Se values measured in this model, as evidenced by the regression coefficient, the high partial R^2 statistic, and the high F statistic (Table 4).

Providing supplemental feed on pasture also had a significant effect on the average values of Se in the herd. This may be explained in several ways. Producers providing supplemental feed on pasture may be able to deliver minerals to their cows, including Se, more efficiently than other producers. Selenium values in the supplemental feed may be elevated or the process of providing supplemental feed may result in enhanced utilization of "free-choice mineral mix" in a pasture scenario. Moreover, producers who provide supplemental feed on pasture are probably more aware of the nutritional needs of cows and, as a consequence, cows that receive supplemental feed are on a higher overall nutritional plane than are cows that are left to rely on pasture alone.

The use of pregnancy diagnosis also had a significant association with higher average Se values. This is unlikely to be a causal association. This variable is a proxy for the level of management in a beef cow-calf herd. It could be hypothesized that producers who utilize pregnancy diagnosis are more progressive and have an overall higher level of management. Therefore, these producers would be more likely to ensure that their cows receive adequate nutrition.

It is interesting to note that neither of the 2 methods of Se supplementation (oral or parenteral) had significant effects on the average values of Se. However, most of the herd owners who utilized parenteral Se gave Se immediately prior to the calving season. It is unlikely that supplementation with parenteral Se in the spring would have a significant effect on Se blood values at the time of removal from pasture in the fall. Moreover, controlled field trials have demonstrated that parenteral supplementation of Se in cows has no effect on blood Se values after calving (14). Also, providing oral Se supplementation in a "free-choice mineral mix" is dependent on several factors including: the method of delivering the "mineral mix"; the absolute amount of "mineral mix"; and the concentration and availability of Se in the "mineral mix". Therefore, it is not surprising that the relatively crude measurements of Se supplementation utilized in this study were not significantly associated with average Se values in the herd.

Ideally, it would have been desirable to have a higher response rate to the study. The most common reason given for refusing to participate in the study was that producers did not usually handle their cows in the fall for any procedures, such as pregnancy diagnosis, which would allow for convenient blood sampling. If the nonresponders differ significantly from the responders in terms of the Se status, then the low response rate in the study necessitates using caution when extrapolating any of the results to the rest of the beef cow population in Alberta.

In conclusion, it appears that the Se values in soils and plants in particular geographic areas have a strong association with values of Se in whole blood in cow herds coming off pasture. However, some of the negative effects of being in a low Se area can be overcome by more progressive nutritional management practices.

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